

Operating Systems + Networking

How is a new program launched
from the shell?

File Path

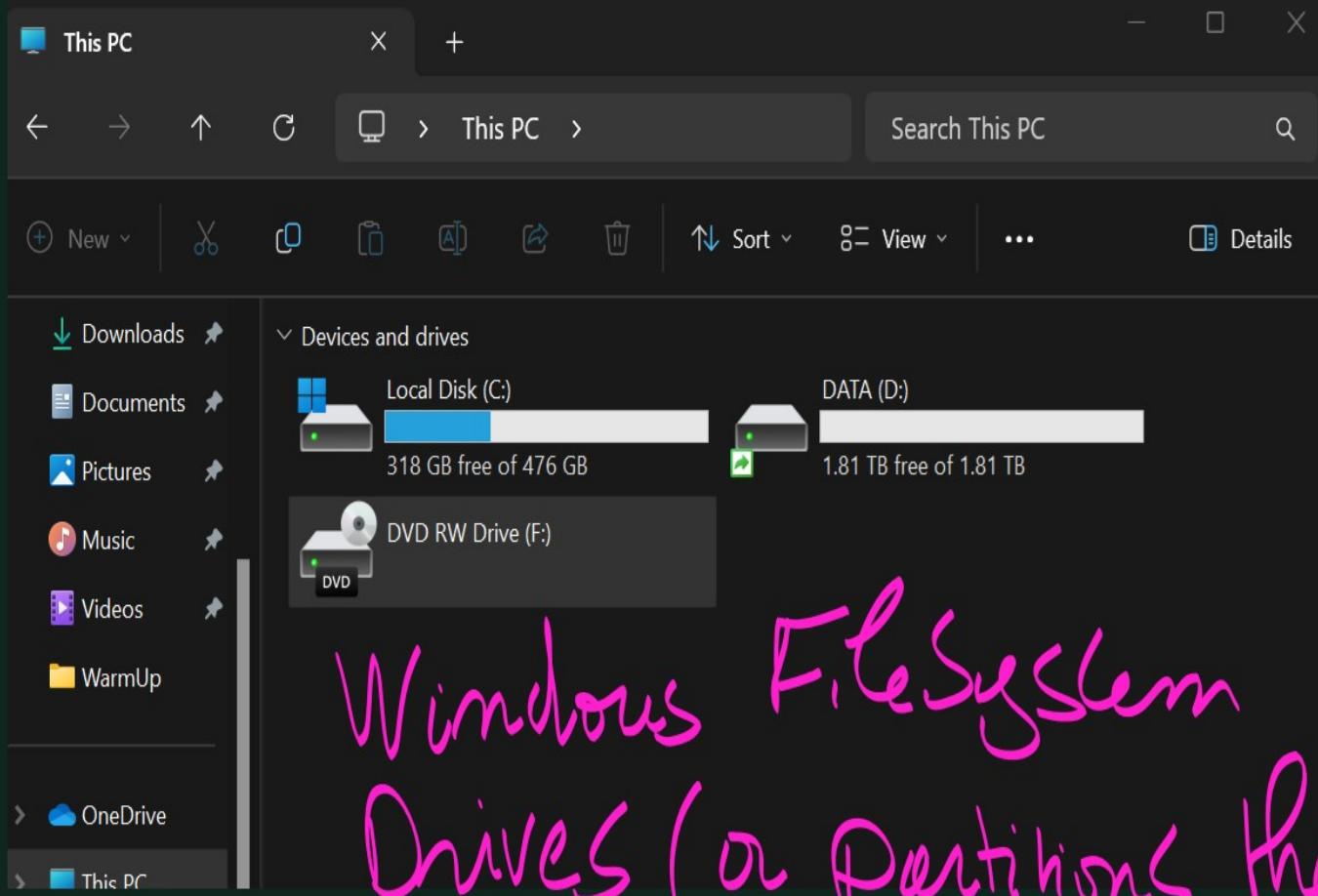
File System (fs) organised by
the OS

FS: Another layer of software
above the media

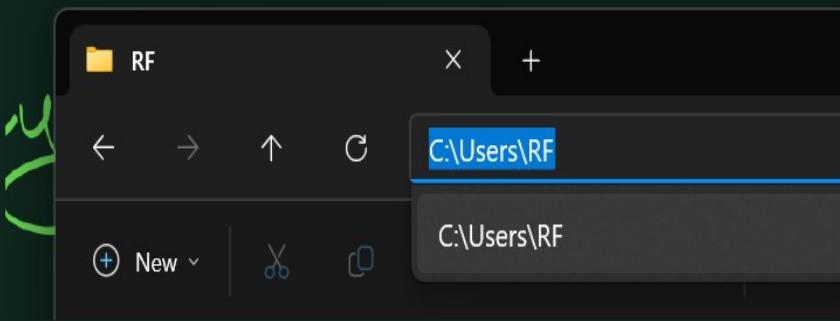
Media Formats { ext3
ext4
(Linux)

HFS
AppleB

FORMAT
ex: FAT
NTFS (current Windows)
exFAT



Windows FileSystem
Drives (or Partitions thereof)
are allocated a letter
(regardless of their format)



A typical Windows Path
from drive letter to a target
separated by "\\"
↙ Main point of entry for any path
(Drive letter)

All tools

fisher@RonaldFisher: ~ X + v

Windows Subsystem for Linux is now available in the Microsoft Store!
You can upgrade by running 'wsl.exe --update' or by visiting <https://aka.ms/wslstorepage>
Installing WSL from the Microsoft Store will give you the latest WSL updates, faster.
For more information please visit <https://aka.ms/wslstoreinfo>

Welcome to Ubuntu 22.04.2 LTS (GNU/Linux 4.4.0-22621-Microsoft x86_64)

- * Documentation: <https://help.ubuntu.com>
- * Management: <https://landscape.canonical.com>
- * Support: <https://ubuntu.com/advantage>

This message is shown once a day. To disable it please create the
`/home/fisher/.hushlogin` file.

fisher@RonaldFisher:~\$

No drive letters or any similar
concept on the
Unix filesystem
There is only ONE FS, regardless of
Storage devices



Unix / Linux

one device
mounted to \backslash

Fully
abstracted
from devices

Devices
are
"mounted":
into the FS
(into any folder)



"Forward slash" is
the ROOT of the FS

\hookrightarrow USR

\hookrightarrow etc

\hookrightarrow bin \rightarrow /bin

\hookrightarrow var
 \hookrightarrow logs \rightarrow /var/log
 \hookrightarrow web

/var/logs/web
could
be
mounted
to another
device

On Unix EVERYTHING

is a file

by software design

The I/O are fully abshocled

With 3 standard files (from hardware)
(2+1)

STDIN

(Standard Input file)

STDOUT

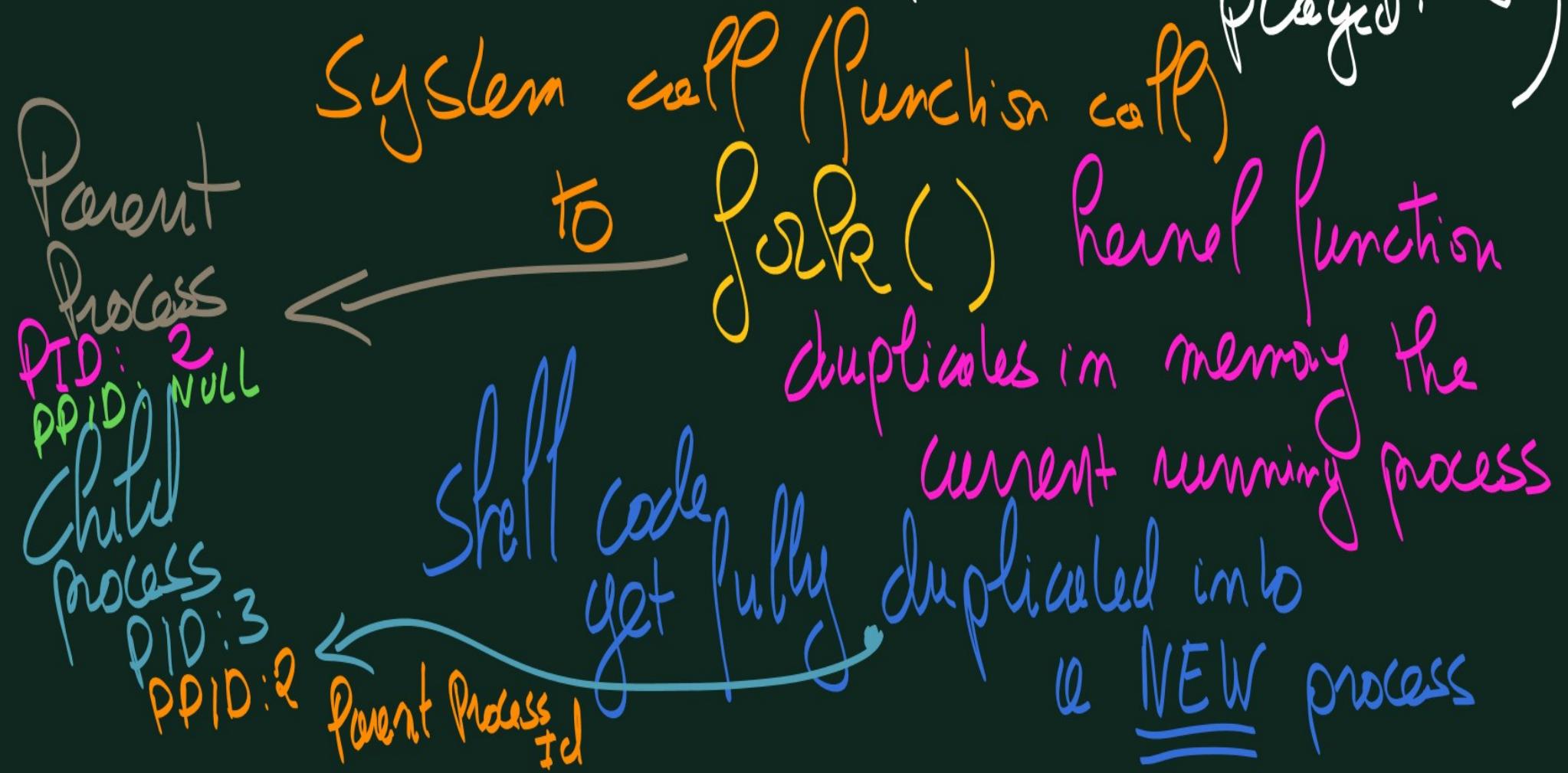
(output)

STDERR

(error)

These files are "mounted" or when connected to a device

Launching a new program
the Shell runs (the "tape is being played")



At launch, a shell looks at its
PPID (Parent Process ID)

If not NULL

↳ calls `exec(path to Exec)`

`exec` replaces the memory
of current running program by the one given in
`binary content` (Kernel function)
parameters

Multitasking: an engineering illusion

Multitasking **Cooperative** (80's 90's)
Programs are coded to call **sleep()** function
so that another can be run
After calling sleep() the **SCHEDULER** can run

PREEMPTIVE scheduling
by the Scheduler(Kernel)

Preemptive Scheduling \rightarrow Relies on HARDWARE

PIC

P_1 & P_2 are loaded in Memory
Kernel is loaded too

P_1 runs at every QUANTUM OF TIME
it will be halted by the PIC
The PIC is also programmed with the memory location of SCHEDULER

At any given point of time

the state of a machine

is "simply" defined as

all the CPU registers values

around 32 kB of data per core (2024)

⇒ CONTEXT of CPU

CONTEXT SWITCH

↳ copy all CPU registers in RAM
A precise "PAUSE BUTTON"

P1 runs



↳ Halled by PIC after
quantum of time ($\sim 20\text{ms}$ on
Windows)

Infinite
loop
for as long
as

Must
be run
by OS

Within
the Quantum

↳ Save the CPU context (Registers values)
in RAM (in a kernel owned
area)

↳ Run the Scheduler Code

. Which program must run next
(round robin type of algorithms)

↳ Restores the context in CPU of
selected program.

Scheduling is done at

THREAD - level

NOT process-level



Details

 Run new task

∅ End task

3

Name	PID	Status	User name	CPU	Memory (ac...)	Threads	Architec...	Description
System Idle Process	0	Running	SYSTEM	98	8 K	40		Percentage of time the processor is idle
System interrupts	-	Running	SYSTEM	00	0 K	-		Deferred procedure calls and interrupt service routines
System	4	Running	SYSTEM	00	20 K	367		NT Kernel & System
ms-teams.exe	14960	Running	RF	00	839,308 K	483	x64	Microsoft Teams (work or school)
TeamViewer/Desktop....	19028	Running	SYSTEM	00	663,056 K	50	x64	TeamViewer
svchost.exe	19820	Running	LOCAL SER...	00	25,856 K	7	x64	Host Process for Windows Services
dwm.exe	1428	Running	DWM-1	00	73,632 K	44	x64	Desktop Window Manager
TextInputHost.exe	17792	Running	RF	00	67,852 K	62	x64	TextInputHost
lolaos.exe	19644	Running	RF	00	233,328 K	42	x86	lolaos
esrv_svc.exe	13212	Running	SYSTEM	00	192,624 K	101	x64	Intel(R) System Usage Report
msedgewebview2.exe	19756	Running	RF	00	567,104 K	38	x64	WebView2: Sharing control bar Microsoft Teams
Taskmgr.exe	2232	Running	RF	00	76,416 K	46	x64	Task Manager
TeamViewer_Service.e...	5760	Running	SYSTEM	00	69,172 K	37	x64	TeamViewer
mongod.exe	5776	Running	NETWORK ...	00	277,016 K	36	x64	MongoDB Database Server
nvcontainer.exe	12740	Running	RF	00	74,908 K	28	x64	NVIDIA Container
msedgewebview2.exe	14976	Running	RF	00	85,708 K	62	x64	WebView2 GPU Process
msedgewebview2.exe	18856	Running	RF	00	49,804 K	47	x64	View Manager
NVDisplay.Container....	3476	Running	SYSTEM	00	24,084 K	32	x64	NVIDIA Container
MsMpEng.exe	5524	Running	SYSTEM	00	192,104 K	74	x64	Antimalware Service Executable
audiogd.exe	7180	Running	LOCAL SER...	00	5,744 K	7	x64	Windows Audio Device Graph Isolation
tv_x64.exe	13596	Running	SYSTEM	00	1,500 K	2	x64	TeamViewer
svchost.exe	3980	Running	SYSTEM	00	14,604 K	8	x64	Host Process for Windows Services
Secure System	204	Running	SYSTEM	00	81,820 K	-	x64	NT Kernel & System
Registry	256	Running	SYSTEM	00	4,756 K	4	x64	NT Kernel & System
smss.exe	820	Running	SYSTEM	00	288 K	2	x64	Windows Session Manager
csrss.exe	1132	Running	SYSTEM	00	1,640 K	18	x64	Client Server Runtime Process
wininit.exe	1256	Running	SYSTEM	00	1,064 K	2	x64	Windows Start-Up Application
csrss.exe	1276	Running	SYSTEM	00	1,504 K	19	x64	Client Server Runtime Process

Threads	Architecture	Description
40		Percentage of time the processor is idle
-		Deferred procedure calls and interrupt service routines
367		NT Kernel & System
483	x64	Microsoft Teams (work or school)
50	x64	TeamViewer
7	x64	Host Process for Windows Services
44	x64	Desktop Window Manager
62	x64	TextInputHost
42	x86	Iolaos
101	x64	Intel(R) System Usage Report
38	x64	WebView2: Sharing control bar Microsoft Teams
46	x64	Task Manager
37	x64	TeamViewer
36	x64	MongoDB Database Server
28	x64	NVIDIA Container
62	x64	WebView2 GPU Process
47	x64	WebView2 Manager
32	x64	NVIDIA Container
74	x64	Antimalware Service Executable
7	x64	Windows Audio Device Graph Isolation
2	x64	TeamViewer
8	x64	Host Process for Windows Services



A program == Process (P i O)

- ↳ 1 thread (minimal)^{mono threaded}
- ↳ > 1 (multi-threaded)

Threads are "Units of Execution"
Portions/Sections of code subject
to multiplexing / scheduling

Any multi-threaded program

competes with itself

to acquire scheduling time!

Example: large I/O need

Thread 1

⚠ Race condition

Thread 2

But the compute code could
start before end of full read

chrome.exe	3876	Running	RF	00	1,468 K	7	x64	Google Chrome
chrome.exe	10236	Running	RF	00	11,696 K	10	x64	Google Chrome
chrome.exe	13412	Running	RF	00	5,908 K	14	x64	Google Chrome
chrome.exe	8064	Running	RF	00	10,912 K	16	x64	Google Chrome
chrome.exe	5536	Running	RF	00	13,864 K	21	x64	Google Chrome
chrome.exe	5924	Running	RF	00	10,328 K	21	x64	Google Chrome
chrome.exe	8472	Running	RF	00	93,524 K	21	x64	Google Chrome
chrome.exe	20572	Running	RF	00	14,440 K	23	x64	Google Chrome
chrome.exe	13984	Running	RF	00	44,744 K	31	x64	Google Chrome
chrome.exe	4840	Running	RF	00	43,696 K	38	x64	Google Chrome
chrome.exe	21864	Running	RF	00	69,572 K	51	x64	Google Chrome

} Higher probability
of being scheduled

Chrome (and web browsers in general)

Multi-Process (usually one per Tab)

mostly when one crashes, the process

Multi-Threaded?

without affecting other tabs

HTML CSS JS Picture
Audio Video encryption...

We need to talk about Python

Multi Threaded code in Python;

- easy to write
- Should never be used
because of the Global Interpreter lock (gil)

⇒ Multi-processing code in Python

Mono-threaded code in multiple
processes (multiple
interpreters)

But before anything

Is my algorithm
parallelisable?

Computer Science
Question

Networking

Why: Cloud Computing
Skype = Networking
TCP/IP networking

I'm using a "plain old phone"
Wired, to call from Nice to LA, CA

How does it work? Purely analogue

Plain Switched Telephone Network (PSTN)

Requirement: A continuous electric
Signal must connect the
two phones

Each line is
connected to a local Phone Exchange
within a few Km (PEX) of where you
are

The connection (ϕ) is conducted
dynamically along a principle

To the next nearest & available PEX until the last one
↳ the one you call the target is connected

Manually by Iterators
Automated by software (programmable relays)

The PSTN network (copper wires)
allows analogue digital data
Different Modulation / Demodulation (Modem)
As long as Signal is continuous

How can we send "data" between
East & West coast of US
in case of nuclear war?

Can we change the nature of
the Payload transmission

Actual Data to be Transmited

Can it be discrete instead of continuous

The payload content must be
Subset into smaller "packets"

Apply the same ROUTING principle

Exchange packets to the next nearest &
available route

Practically

① Subsetting the payload into packets?

Digital computers, packetised network
is more suited to digital communication

② Routing algorithm based on next-based available route : no guarantee the packets will arrive in order

Some mechanism for mngt must be added
to payload: Packet Number
(at least)

③ Some packets may never arrive
You need a reception acknowledgement

protocol

"I'm missing a packet!"

Either full \hookrightarrow cannot reconstruct the payload
or not

Algorithmic decidability: each packet must
be of the same size

The Transmission Control Protocol (TCP)

See its principles on previous slides

TCP is designed **AGNOSTIC** to
the Layer of networking media

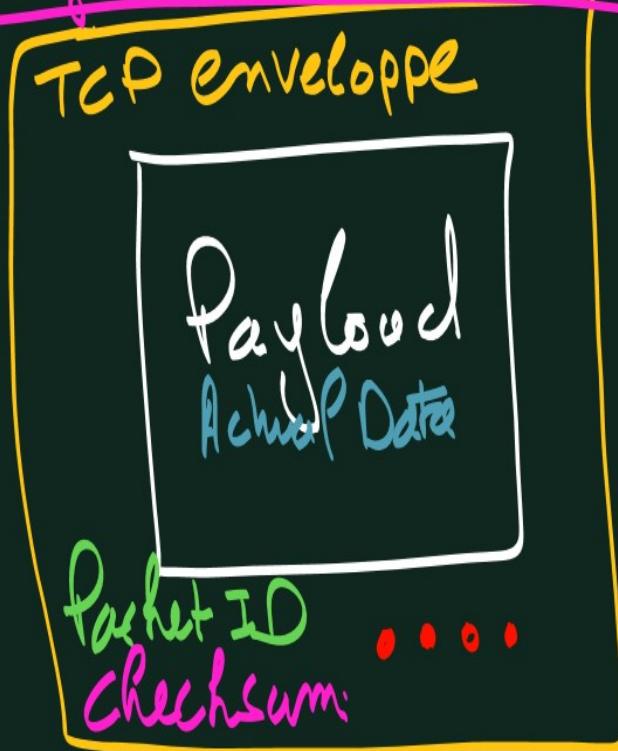
As long as your networking media has a driver
TCP can be used

Allowing routing over an interconnection
of Networks : INTERNET

Representation of packets

TCP adds data to transmission
TCP guarantees delivery (for its own management)

Sender computes checksum and writes it in enveloppe



Receivers compute the checksum and compares to the enveloppe one

Transmission lines being by nature unreliable

UDP : User Datagram Protocol

Same as TCP except

In TCP
code

for guarantee of delivery

The software of server & client

Manage their own acknowledgement
(or more)

The Internet Protocol (IP)

It's your telephone Number!

IPv4 ($> 50\%$ of Internet services today)
is a 32 bit coded address

134.59.22.1 → an IPv4 address

[0;255] for each block
 $2^8 \times 4 \rightarrow 2^{32}$
In a string of characters? No!
 $IP = "134.59.22.1"$
One integer per digit → No!

IP addresses are MASKED VALUES
CPU can read "mosked" in HW

2^{32} max addresses : 4 Billions (at the time, until huble)

For limiting memory consumption

AND arithmetic

134.59.22.1 is stored as ONE 32 bit value
in memory, by zones of 8 bits

One 8 bit value Second 8 bit value Third Fourth == a word of 32 bit
for which we need 32 bit CPU of Memory

The last allocatable IPv4 address
Was given in 2013

Without breaking the Internet

whatismyipaddress.com



WhatIsMyIPAddress.com

PUBLIC IP

IP LOOKUP

IPv4: ? **217.128.27.64**

??

My IP Information:

ISP:	Orange S.A.
City:	Chatillon
Region:	Auvergne-Rhone-Alpes
Country:	France

Enter Keywords or IP Address...

Search

ABOUT PRESS BLOG SUPPORT

Ethernet Status

General

Connection

- IPv4 Connectivity: Internet
- IPv6 Connectivity: Internet
- Media State: Enabled
- Duration: 5 days 13:31:57
- Speed: 1.0 Gbps

Activity

Sent — Received

Bytes: 16,646,626,401 | 32,942,963,518

Details...

Properties Disable Diagnose Close

Control Panel

information and set up connections

Access type: Internet
Connections: Ethernet

PRIVATE IP

??

Network Connection Details:	
Property	Value
Connection-specific DNS ...	home
Description	Realtek Gaming 2.5GbE Family Contr
Physical Address	04-7C-16-04-D8-DA
DHCP Enabled	Yes
IPv4 Address	192.168.1.51
IPv4 Subnet Mask	255.255.255.0
Lease Obtained	Wednesday, April 10, 2024 1:30:07 AM
Lease Expires	Tuesday, April 16, 2024 1:30:07 PM
IPv4 Default Gateway	192.168.1.1
IPv4 DHCP Server	192.168.1.1
IPv4 DNS Server	192.168.1.1
IPv4 WINS Server	
NetBIOS over Tcpip Enab...	Yes
IPv6 Address	2a01:cb1d:b01:4100:6b7e:bb93:3feb:9
Temporary IPv6 Address	2a01:cb1d:b01:4100:149a:ea6f:69c6:4
Temporary IPv6 Address	2a01:cb1d:b01:4100:3891:f21d:6de7:e
Temporary IPv6 Address	2a01:cb1d:b01:4100:4dbe:adad:86d6:1
Temporary IPv6 Address	2a01:cb1d:b01:4100:ac11:8ba0:c96d:1

See also

Internet Options

Windows Defender Firewall



02 PM

5/2024

like the phone system, where
there could be one public phone number
(ex. DSTI) with "private" phone lines

Publicly accessible Internet Service
AND their requesters

Need a publicly routable IP @
which can be shared by multiple devices

At home, your "Box" is a

Network

Address

Translation

Server

(in the "box"
as server)

our OS are
clients)

Router : creates a Local Area Network (LAN)
Addressed in the "private IP" ranges

IAP : Internet Access Point

Connecting you to your Internet Service Provider(s)

Your ISP leases you a public routable IP
(Wide Area Network - WAN)

Private IPv4 addresses

Ranges

RFC 1918 name

IP address range

Classful description

24-bit block

10.0.0.0 – 10.255.255.255

"**1 class**"
single class A network

20-bit block

172.16.0.0 – 172.31.255.255

16 contiguous class B networks

16-bit block

192.168.0.0 – 192.168.255.255

"**256 classes**"
256 contiguous class C
networks

} By human Design
of IPv4

3 classes of LAN IPs

A router must know where the payload goes
Basically, in or out of LAN?

Any Network card, IP addressed

3 MANDATORY VALUES

① LAN IP @

② Subnet Mask

③ IP address of router (gateway)

Scenario 1

PCI

IP: 192.168.10.20

NetMask: 255.255.255.0

Router: 192.168.10.1

Assuming LAN

addressed in 192.168.10.2

Subnet Mask resolution

$$255_{10} = 1111111_2$$

XBOX

IP: 192.168.10.50

NetMask: 255.255.255.0

Router: 192.168.10.1

$$11111111111111111111111100000000$$

$$\begin{array}{r} 111111111111111111111111 \\ \downarrow \text{from NSB backwards} \\ \text{"Blank value"} \\ \text{Multiply} \end{array}$$

$$192_{10} = 11000000_2$$

PCI sends data to XBOX

How can PCI compute if XBOX is on the same LAN?
(Same network)

Sender IP software
will **MASKED**
MULTIPLY 8 bits
bit by bit
the destination IP
With the Netmask

Unchanged **(192.168.0.10)** **SAME**
the rest of NetMask is zeroed
"unblocked"
The two devices are on same network

Scenario 1 SAME Assuming LAN
PCI: IP: 192.168.10.20 addressed in 192.168.10.2
NetMask: 255.255.255.0 Subnet Mask resolution
Router: 192.168.10.1 $255_{10} = \begin{smallmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 2 \end{smallmatrix}$
XBOX: IP: 192.168.10.50
NetMask: 255.255.255.0 $\xrightarrow{\text{From MSB backwards}}$ 00000000
Router: 192.168.10.1 "Block value"
Multiplication
PCI sends data to XBOX
How can PCI compute if XBOX is on the same LAN?
(Same network)

192.168.10.50 @

255.255.255.0 NetMask

192.168.10.1 Router

↳ send data to 134.59.22.1

11000000
-(192)

0011111
(255)

10000110
(134)

10 different → not same LAN
→ out to router

[S24] WarmUp : Blackboard files

10-04-2024.pdf

X | SHA256 - Online Tools

x G 134 in binary - Google Search x +

C:\Users\RF>tracert 134.59.22.1

OUT OF LAW

IP conference

Tracing route to fs-info-01.unice.fr [134.59.22.1]
over a maximum of 30 hops:

```
1 <1 ms    <1 ms    <1 ms livebox.home [192.168.1.1] GATEWAY
2   1 ms    1 ms    1 ms 80.15.224.25
3  16 ms    16 ms   16 ms 92.184.150.30
4  16 ms    16 ms   16 ms ae43-0.nimar202.rbc1.orange.net [193.252.103.241]
5  15 ms    15 ms   15 ms 193.252.137.54
6   *       *       * Request timed out.
```

```
7 15 ms 15
8 26 ms 26 🛡️ ➜ Administrator: Windows Powe X + ▾
9 28 ms 28
10 26 ms 27 Windows PowerShell
11 29 ms 29 Copyright (C) Microsoft Corporation. All rights reserved.
```

13 33 ms 34 Install the latest PowerShell for new features and improvements! <https://aka.ms/PSWindows>

```
PS C:\Users\RF> tracert 192.168.1.25
```

INSIDE LAN

Tracing route to ted-codd-nuc-2.home [192.168.1.25]
over a maximum of 30 hops:

\ Direct exchange (no gateway)



What does 1



Middle East crisis

Live

France joins western allies in calling for Israel to avoid escalation after Iran attack

11m ago

The Czech Republic is the latest country to say that it has summoned an...

33m ago

A UN report has said that Israel has destroyed over 3,000 buildings within...

40m ago

Reuters reports that Israel's military has confirmed that four of its...



Some Public IP
for TheGuardian.com

How do the
Paxols end up
in the right?



Israel

War cabinet to meet again to consider response to Iran's attack

4h ago

'I hope everything is behind us'

Israelis take stock after night of airstrikes

Phone Tab?

All-out war or de-escalation
What will the Netanyahu

